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L3: Entry 29 of 40 File: USPT Apr 11, 1989

DOCUMENT-IDENTIFIER: US RE32905 E
TITLE: Satellite communications system and apparatus

Abstract Text (1):
A satellite communication system, which is inherently power limited, employing spread spectrum techniques in order to trade-off bandwidth for small ground station antennas. In a one-way system embodiment a central station transmits data to a satellite for relay to a large number of small antenna receiving stations, the transmissions being spread spectrum encoded with spreading code lengths selected to provide adequate data recovery at the least sensitive station to which the transmissions are directed. Spreading codes may also function to address particular stations. In a two-way system embodiment, the central station additionally functions as a terrestrial relay station. A plurality of small antenna transmitting stations, at least one of which may be at the same site as a receiving station, transmit code division multiplexed data via the satellite to the central relay station using sufficiently long and distinct spreading codes as to permit adequate data error rates and to distinguish the transmissions of the various stations. The central relay station reformats the received data for retransmission to the satellite for relay to the receiving stations.

Brief Summary Text (44):
The spreading codes used in the inbound link 22, 23 and the outbound link 2, 12 differ. The outbound codes are shorter in length and are unique to a class of remote stations. Stations within a class are differentiated by minimal addressing within the bit stream. The inbound codes are significantly longer and are unique to individual remote stations. Among the reasons for a longer inbound code are: (1) the need for a higher processing gain to compensate for the low signal levels which result when a small diameter antenna 21 is used to transmit from the remote station 4A to satellite 3; (2) the low power of a small transmitter designed to be low in cost and low in amount of interference with terrestrial microwave networks operating in the same frequency band; and (3) the larger number of uncorrelated codes available with a longer code length (as required by the CDM format utilized).

Brief Summary Text (46):
The one-way transmission network comprises a central station 14, a geostationary satellite 3, and remote stations 4. The central station 14 comprises user input links 11, an intelligent data concentrator/encoder 10A, and a transmitter 17. The geostationary satellite 3 comprises a transponder system which receives signals from the central station 14 at one frequency, for example 6 GHz, and translates, amplifies and transmits the signal at a different frequency, for example 4 GHz, to the remote stations 4. The remote stations 4 receive the satellite-relayed transmission 12 from the central station 14 using small diameter dish antennas 5. The received signal is then detected by either of two processes. The first process requires that the received signal be first despread using the local reference code, then demodulated, while the second process involves first the demodulation of the received signal, then the despreading of the demodulated waveform.

Brief Summary Text (70):
Sixth, since the remote stations are microprocessor controlled (microprocessor 190, which can be a general purpose microprocessor) each remote station 4 may be reprogrammed, by transmissions from the central station 14, to accept different codes of differing lengths, for example, when an increase in satellite transmitter power levels permit fewer chips per bit or when a more stringent bit error rate leads to a requirement for more chips per bit.

Brief Summary Text (74):
Finally, because the system utilizes a small portion of the transponder bandwidth of the geostationary satellite 3, a number of similar channels utilizing different carrier frequencies within the transponder bandwidth may be implemented to expand the capacity of the transponder up to the limits of the available transponder power. However, the preferred embodiment utilizes a single outbound channel with all or a substantial fraction of the transponder power being concentrated within that channel.

Detailed Description Text (3):
The selection of the spreading code length was influenced by: receiving antenna (5) size, receiver noise figure, transponder (3) power, bandwidth of the transmitted signal, the required bit error rate, the number of unique codes required, the data rate, and the chip rate selected, among other factors.

Detailed Description Text (10):
Geostationary Satellite Transponder

Detailed Description Text (11):
In the preferred embodiment the geostationary satellite 3 is used to relay transmissions between the centrqal station 14 and remote stations 4 and vice versa. The heart of the satellite is a transponder which receives signals 2 at a nominal 6 GHz frequency and which retransmits 12 such signals at a nominal 4 GHz frequency. The maximum radiated power permitted to be transmitted by the transponder is set by FCC regulation and is -149 dBW per square meter per 4 KHz band. The effective isotropic irradiated power (EIRP) transmitted by the geostationary satellite 3 in the preferred embodiment of the invention is 20 to 32 dbW. For a chip rate of 2.4576 MHz the bandwidth of the signal relayed by the geostationary satellite 3 is approximately 4.9 MHz. The power of the transmitter may be increased to 32 dBW in the same 4.9 MHz bandwidth without exceeding the flux density limits. Since the typical bandwidth of a satellite transponder is 36 MHz, it is clear that the relayed signal is power rather than bandwidth limited.

Detailed Description Text (60):
Once the data have been spread, they are applied to balanced modulator 215 which causes the 70 MHz local oscillator signal 216, applied to the other multiplier input, to be BPSK modulated. Note that the local oscillator 216 is controlled by a crystal maintained under environmentally controlled conditions, thereby promoting excellent long term stability of the 70 MHz subcarrier frequency. Modulation is performed at a high frequency level for ease of up-conversion. The output of the balanced modulator 215 is then frequency translated to the nominal 6 GHz carrier frequency, amplified, and transmitted, using a large dish antenna 8 to the geostationary satellite 3.

Detailed Description Text (66):
The microprocessor 190 controls the timing of the application of the data to the multiplier (XOR gate) 239 as well as the timing and generation of the spreading code 30.

Detailed Description Text (70):
To summarize, the add-on transmitter circuitry 230 receives data, under microprocessor 190 control, from a remote station user I/O terminal 191. The microprocessor 190 causes the code generator 30 to generate the remote stations's two 2048 chip CDM codes, as well as adjusts the frequency selector 243 which sets the carrier frequency. XOR gate 239 multiplies the data with the spreading codes, all under microprocessor 190 control. The output of XOR gate 239 modulates the frequency synthesized carrier in balanced modulator 234. The output of the balanced modulator is then frequency translated 233 to the desired frequency and transmitted via geostationary satellite 3 to the central station 14 using a 4 foot diameter dish antenna 21.

Detailed Description Text (72):
Referring to FIG. 3, the central station receiving circuitry 231 allows the station to receive signals from all remote stations 4A served by the geostationary satellite 3. With chip rate for the system selected to be approximately 2.45 MHz, the

null-to-null bandwidth of one channel is 2.times.2.45 MHz=4.9 MHz. In addition, each channel may accommodate 2045.div.2=1024 users assuming two codes per user. (The number of orthogonal codes is approximately equal to code length.). Theoretically, the central station 14 would be capable of receiving approximately 11.times.1024=11.264 different remote station transmissions. (Assumes 36 MHz transponder bandwidth and signals positioned 1.2.times.R center-to-center spacing where R equals chip rate. This spacing is the closest practical bandwidth before encountering serious intersymbol interference.)

Detailed Description Text (73):
In the preferred embodiment, the bandwidth chosen per channel is 4.9 MHz (2.times.2.45 MHz), thereby permitting six or seven channels within the 36 MHz bandwidth of a standard satellite transponder, with one of those channels reserved for the outbound link. Therefore, the central station 14 should be capable of receiving data from at least 5.times.1024=5120 different remote stations per 36 MHz transponder.

Detailed Description Text (74):
Signals received by the 60 foot receiving antenna 270 of the central station 14 are first mixed (271) down to nominal 70 MHz IF frequency. The signal is then separated into the five transponder channels by L.O./mixer combinations 272. Associated with each L.O. mixer output is a bank of despreading receivers 273. See FIG. 3. Each despreading receiver is loaded with the code sequence of a different potential transmitting remote station 4A. The number of despreading receivers per channel cannot economically be made equal to the total number of remote stations using a channel, therefore the incoming signal is compared to only a portion of the possible codes at one time. The remaining codes are cycled into the despreading receiver 273 on successive cycles of the search. The number of receivers 273 in the bank are selected statistically in light of the expected traffic patterns and acceptable acquisition period. Typically there are 256 despreading receivers in a bank, and acquisition time takes a maximum of 15 to 30 seconds.

Detailed Description Text (81):
Referring to FIGS. 2 and 3, the operation of the two-way transmission network will be described. At the remote station 4A the user inputs data on I/O device 191, including designation of the remote station to which the information will be sent. Microprocessor 190 routes the data to XOR gate 239 and at the same time causes code generator 30 to generate the remote station 4A CDM spreading codes. The data are spread in synchronization with the system sync timing. The spread data are then transmitted CDM 22 to the geostationary satellite 3 using a 4-foot dish antenna 21. The geostationary satellite 3 receives the transmission and relays 23 the signal to the central station 60-foot dish 270. The central station receiving circuitry 231 matches the signal with a local reference code obtained from memory and circulated in a despreading receiver 273. The reference code which matches the signal identifies the remote station from which the signal was transmitted. The data and address information are despread and the data respread in the addressed station's spreading code. The spread information is transmitted Time Division Multiplexed, 2, 12 Binary Phase Shift Keying via the geostationary satellite 3 to the addressed remote station 4. The addressed remote station 4 detects the data intended for it in the transmitted stream. The data are first despread, then demodulated to yield the transmitted data. Chip sync 103 maintains chip and bit synchronization, and frame sync 161 maintains code and frame alignment. The microprocessor 190 forms the despread data into bytes and then, with appropriate controls, outputs the data 191 to the user.

Other Reference Publication (4):
"Multiple Access to a Hard Limiting Communications Satellite Repeater", J. M. Aein, Spread Spectrum Techniques, Jan. 1, 1976.

Other Reference Publication (42):
"Communication Satellite Processing Repeaters", Huang et al., Proc. IEEE, vol. 59, No. 2, 1971.

Other Reference Publication (89):
"Modulation Techniques for Multiple Access to a Hard-Limiting Satellite Repeater",

Schwartz, et al., Proceedings of the IEEE, vol. 54, No. 5, pp. 763-777, May 1, 1966.

Other Reference Publication (98):
"A Processing Satellite Transponder . . . Mobile Users", Viterbi, Proceedings of 4th Intern. Confer. on Digital Satellite Comm., Montreal, pp. 116-174, Oct. 23, 1978.

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L3: Entry 13 of 40 File: USPT Feb 22, 2000

DOCUMENT-IDENTIFIER: US 6028884 A
TITLE: Method and apparatus for measuring nonlinear effects in a communication system

Brief Summary Text (5):
One type of multiple access communication system used for transferring information among a large number of system users is based on code division multiple access (CDMA) spread spectrum techniques. Such communication systems are disclosed in the teachings of U.S. Pat. No. 4,901,307, which issued Feb. 13, 1990 under the title "Spread Spectrum Multiple Access Communication System Using Satellite Or Terrestrial Repeaters", and U.S. Pat. No. 5,691,974, which issued Nov. 25, 1997, under the title "Method And Apparatus For Using Full Spectrum Transmitted Power In A Spread Spectrum Communication System For Tracking Individual Recipient Phase Time And Energy," which are both assigned to the assignee of the present invention, and incorporated herein by reference.

Brief Summary Text (9):
In a typical CDMA spread-spectrum communication system, channelizing codes are used to discriminate between signals intended for different users within a cell or between user signals transmitted within a satellite beam, or sub-beam, on a forward link. That is, each user transceiver has its own orthogonal channel provided on the forward link by using a unique `covering` or `channelizing` orthogonal code. Walsh functions are generally used to implement the channelizing codes, with a typical length being on the order of 64 code chips for terrestrial systems and 128 code chips for satellite systems. In this arrangement, each Walsh function of 64 or 128 chips is typically referred to as a Walsh symbol. The derivation of Walsh codes is more fully disclosed in U.S. Pat. No. 5,103,459 entitled "System And Method For Generating Signal Waveforms In A CDMA Cellular Telephone System", which is assigned to the assignee of the present invention and incorporated herein by reference.

Detailed Description Text (8):
Mobile stations or user terminals 220 and 222 each have or comprise a wireless communication device such as, but not limited to, a cellular telephone, a data transceiver or transfer device (e.g., computers, personal data assistants, facsimile), or a paging or position determination receiver. Typically, such units are either hand-held or vehicle mounted as desired, but fixed units or other types of terminals can also be used where remote wireless service is desired. This latter type of service is particularly suited to using satellite repeaters to establish communication links in many remote areas of the world.

Detailed Description Text (13):
As discussed above, each base station or gateway transmits a `pilot` signal throughout a region of coverage. For satellite systems, this signal is transferred within each satellite `beam` and originates with gateways being serviced by the satellite. A single pilot is typically transmitted by each gateway or base station for each satellite-to-user beam frequency. This pilot is shared by all users receiving signals over that beam. This technique allows many traffic channels or user signal carriers to share a common pilot signal for carrier phase reference.

Detailed Description Text (28):
At least one gateway control processor 420 is coupled to receiver modules 424, transmit modules 434, and baseband circuitry 422; these units may be physically separated from each other. The control processor provides command and control signals to effect functions such as, but not limited to, signal processing, timing signal generation, power control, handoff control, diversity combining, and system

interfacing. In addition, the control processor assigns PN spreading codes, orthogonal code sequences, and specific transmitters and receivers for use in user communications.

Detailed Description Text (35):
For satellite repeater systems, the pilot signal is transferred within each satellite beam frequency and originates with gateways according to the satellite or satellite beam being used for communications links. However, pilot signals can also be transmitted as shared resources over various combinations of beams and sub-beams, using a variety of satellites, gateways, or base stations, as would be apparent to one skilled in the relevant art. The teachings of the present invention are not limited to a specific pilot transmission scheme in a communications system, nor by the type of shared resource being used.

Detailed Description Text (38):
One approach to solving this problem is open loop pilot signal power control. In this approach, the gateway makes an open loop estimate of the path gain in the forward link, i.e., from the modulator in the gateway, via the satellite transponder, to the user terminal. The gateway uses this estimate to control the pilot signal power transmitted by the gateway, and, thus, to control the pilot signal power transmitted by the satellite transponder. A significant problem with this approach is that this open loop estimate will contain errors due to the uncertainties of the path gain, including uncertainties in the satellite transponder electronic gain, gain compression of the satellite transponder high power amplifiers, antenna gain and path loss due to atmospheric effects such as rain attenuation. The error due to these gain uncertainties can be quite large.

Detailed Description Text (62):
One embodiment of apparatus useful for implementing the process of the present invention is illustrated in FIG. 9. As in the case of FIG. 6, just exemplary Walsh coding logic, such apparatus being well known, is shown for data channels W.sub.0 through W.sub.N-1 using coding elements 602.sub.0 through 602.sub.N-1.The spreading and other elements are not shown for purposes of clarity. In FIG. 9, data signals a.sub.0 though a.sub.n-1 are transferred as inputs to logic or coding elements 602.sub.0 through 602.sub.N-1, here represented as multipliers with other known logic or processing elements used as desired. The data signals are combined with individual Walsh functions W.sub.iL (i goes from 0 to N-1), where L represents the code or sequence length, to produce covered or coded data. The coded or channelized signals are again summed together in a summation element 604 to form a (multi-channel) CDMA communication signal and provided to an adjustable gain or attenuation element 606, just prior to input to the high power device, component, or system 902 under test. The device could find use in gateways, base stations, or even the satellites.

Detailed Description Text (68):
One alternative embodiment is to provide the test communication signal (multi-channel), such as by presenting multiple channels of data or data intended for different code channels (user terminals) for transfer, through the baseband circuitry in the base station or gateway, at periodic intervals to automatically check the status of, or changes in, operating characteristics of certain components. For example, this is useful for ascertaining changes in the operating characteristics for HPAs located on satellites, which may undergo certain changes in their nonlinear characteristics over time, in response to changes in loading, or when in a powering up mode of operation, as is known. Using the present technique, measurements can be used during system use to counter deleterious effects otherwise encountered due to some of these conditions.

Detailed Description Text (70):
As stated earlier multiple empty or non-data bearing channels can be used for the inventive process. That is, more than one channel may have no data applied in forming a multi-channel communication signal. This can serve to analyze any differences in the orthogonality or loss thereof (energy transfer) among the channels. The nonlinear effects may affect one coded channel more than others, or other processes may be occurring which creates has this impact. It is, therefore, useful to be able to assign multiple empty channels and to compare the WPR for each

of the channels, as a sort of channel "goodness" indicator.

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L3: Entry 4 of 40 File: USPT Jul 23, 2002

DOCUMENT-IDENTIFIER: US 6424831 B1
TITLE: Apparatus and method for paging a user terminal in a satellite communication system

Brief Summary Text (5):
Conventional satellite-based communication systems include gateways and one or more satellites to relay communication signals between the gateways and one or more user terminals. A gateway is an earth station having an antenna for transmitting signals to, and receiving signals from, communication satellites. A gateway provides communication links, using satellites, for connecting a user terminal to other user terminals or users of other communication systems, such as a public switched telephone network. A satellite is an orbiting receiver, repeater and regenerator used to relay information signals. A user terminal is a wireless communication device such as, but not limited to, a wireless telephone, a data transceiver, and a paging receiver. A user terminal can be fixed, portable, or mobile, such as a mobile telephone.

Brief Summary Text (6):
A satellite can receive signals from and transmit signals to a user terminal provided the user terminal is within the "footprint" of the satellite. The footprint of a satellite is the geographic region on the surface of the Earth within the range of signals of the satellite. The footprint is usually geographically divided into "beams," through the use of beam-forming antennas. Each beam covers a particular geographic region within the footprint. Beams may be directed so that more than one beam from the same satellite covers the same specific geographic region.

Brief Summary Text (7):
Some satellite communications systems employ code division multiple access (CDMA) spread-spectrum signals, as disclosed in U.S. Pat. No. 4,901,307, issued Feb. 13, 1990, entitled "Spread Spectrum Multiple Access Communication System Using Satellite or Terrestrial Repeaters," and U.S. Pat. No. 5,691,974, issued Nov. 25, 1997, entitled "Method and Apparatus for Using Full Spectrum Transmitted Power in a Spread Spectrum Communication System for Tracking Individual Recipient Phase Time and Energy," both of which are assigned to the assignee of the present invention, and are incorporated herein by reference.

Detailed Description Text (12):
In an example embodiment, information is transmitted by gateway 122 on forward links 160, 162 utilizing frequency division and polarization multiplexing. The frequency band used is divided up into predetermined number of frequency "channels" or "beams." For example, the frequency band is divided into 8 individual 16.5 MHz "channels" or "beams" using right hand circular polarization (RHCP) and 8 individual 16.5 MHz "channels" or "beams" using left hand circular polarization (LHCP). These frequency "channels" or "beams" are further made up of a predetermined number of frequency division multiplexed (FDM) "subchannels" or "subbeams." For example, the individual 16.5 MHz channels may in turn be made up of up to 13 FDM "subchannels" or "subbeams", each of 1.23 MHz bandwidth. Each FDM subbeam can include multiple orthogonal channels which are typically established using Walsh codes (also referred to as Walsh channels). A majority of the orthogonal channels are traffic channels that provide messaging between user terminals 124 and gateway 122. The remaining orthogonal channels include pilot, sync and paging channels.

Detailed Description Text (16):
In the reverse direction, user terminal 124 transmits information to satellite 116 over user link 164. Satellite 116 receives these signals from multiple user

terminals (over link 164) and frequency division multiplexes them together for the satellite-to-gateway feeder link 166. Reverse link 164 contains traffic channels and access channels.

Detailed Description Text (34):
At least one gateway control processor 320 is coupled to receiver modules 324, transmit modules 334, and baseband circuitry 322; these units may be physically separated from each other. Control processor 320 provides command and control signals to effect functions such as, but not limited to, signal processing, timing signal generation, power control, handoff control, diversity combining, and system interfacing. In addition, control processor 320 assigns PN spreading codes, orthogonal code sequences, and specific transmitters and receivers for use in user communications.

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L3: Entry 6 of 40 File: USPT Nov 13, 2001

DOCUMENT-IDENTIFIER: US 6317420 B1
TITLE: Feeder link spatial multiplexing in a satellite communication system

Detailed Description Text (5):
Some satellite communication systems employ code division multiple access (CDMA) spread-spectrum signals, as disclosed in U.S. Pat. No. 4,901,307, issued Feb. 13, 1990, entitled "Spread Spectrum Multiple Access Communication System Using Satellite or Terrestrial Repeaters," and U.S. Pat. application Ser. No. 08/368,570, filed Jan. 4, 1995, entitled "Method and Apparatus For Using Full Spectrum Transmitted Power In A Spread Spectrum Communication System For Tracking Individual Recipient Phase Time And Energy, " both of which are assigned to the assignee of the present invention, and are incorporated herein by reference.

Detailed Description Text (7):
In a typical CDMA spread spectrum system, channelizing codes are used to discriminate between signals intended for different users within a cell or between user signals transmitted within a satellite sub-beam on a forward link (i.e., the signal path from the base station or gateway to the user terminal transceiver). Each user transceiver has its own orthogonal channel provided on the forward link by using a unique "channelizing" orthogonal code. Signals transferred on these channels are generally referred to as "traffic signals." Additional channels are provided for "paging," "synchronization," and other signals transmitted to system users. Walsh functions are generally used to implement the channelizing codes.

Detailed Description Text (34):
At least one gateway control processor 320 is coupled to receiver modules 324, transmit modules 334, and baseband circuitry 322; these units may be physically separated from each other. Control processor 320 provides command and control signals to effect functions such as, but not limited to, signal processing, timing signal generation, power control, handoff control, diversity combining, and system interfacing. In addition, control processor 320 assigns PN spreading codes, orthogonal code sequences, and specific transmitters and receivers for use in user communication.

Detailed Description Text (39):
As shown here, satellite 116 includes one feed link antenna 508 and at least one user link antenna 512. Feeder link antenna 508 produces a single feeder link "cell" or "superbeam" 510, which communicates with all of gateways 120 within that cell. Information is transmitted over the feeder link using techniques such as frequency division and polarization multiplexing. For example, the feeder link frequency band can be divided into several individual frequency "channels." The number of channels can be doubled through polarization reuse, for example, by using right-hand circular and left-hand circular polarization. For convenience, these channels are referred to herein as "feeder channels." In an exemplary system design, the feeder link contains 16 channels (or beams), each having a bandwidth of 16.5 MHz. Each of these beams is subdivided into 13 CDMA subchannels (or subbeams), each having a bandwidth of about 1.22 MHz. Thus, this type of feeder link supports 208 CDMA channels or subbeams.

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L2: Entry 11 of 18 File: USPT Jun 25, 1991

DOCUMENT-IDENTIFIER: US 5027207 A
TITLE: Television signal transmission system utilizing TDMA technique

Brief Summary Text (6):
Recently a system has been in consideration by present inventors which utilizes the TDMA technique, thereby to transmit television signals from a plurality of transmitting stations to a plurality of receiving stations. The system comprises transmitting stations, more receiving stations, and, for example, a communications satellite. A transponder is incorporated in the communications satellite which can relay a plurality of carriers having different frequencies. One of the carriers is assigned to all transmitting stations. Each TDMA frame of the TDMA signal transmitted from each transmitting station o this carrier is time-divided into a plurality of communication channels. More precisely, each transmitting station inserts television signals an every image frame in the channel which is assigned to the transmitting station, and transmit the television signal to the communication satellite. Each of the television signals consists of a video signal and a audio signal. The video signal is frequency-modulated before being transmitted from the transmitting station. The audio signal is converted to a digital signal and then transmitted from the transmitting station on a subcarrier which has been modulated by QPSK technique. The transponder incorporated in the communications satellite receives the television signals from the transmitting stations, insert them in the various channels, and transmits them to the receiving stations. Each receiving station receives the television signals from the satellite, which are inserted in the various channels, and selects the television signals relayed and inserted in the desired channel. The television signals, thus selected, are stored into an image memory. When necessary, these signals are read from the image memory and processed, thereby displaying a still picture or a strobe-effect sequence of pictures on a monitor screen.

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L2: Entry 15 of 18 File: USPT Nov 2, 1982

DOCUMENT-IDENTIFIER: US 4357700 A
TITLE: Adaptive error encoding in multiple access systems

Abstract Text (1):
In a time division multiple access (TDMA) system, for "multi-path" data communication via satellite repeater, the form of transmitted data is varied adaptively to maintain error-free transmission under varying noise conditions. Adjustments are made on a path selective and channel selective basis to protect only the most vulnerable data in specific transmission paths experiencing noise deterioration. Accordingly any multi-channel burst may contain channels of data in both protected and unprotected forms. A predetermined portion of each channel containing data in unprotected format is used explicitly to designate the destination of the accompanying data and implicitly to distinguish the data format as unprotected. In protected format data including error protective coding is transmitted in two contiguous channels along with information in the first channel explicitly distinguishing the protected format. This format-distinguishing information occupies the space allotted in the unprotected format for designating the data destination. The destination of protectively encoded data is explicitly designated in a separate predetermined space in the associated double-channel slot.

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L3: Entry 5 of 40 File: USPT Jun 18, 2002

DOCUMENT-IDENTIFIER: US 6408178 B1
TITLE: Systems and methods for resolving GPS pseudo-range ambiguity

Brief Summary Text (7):
FIG. 2 illustrates a conventional celestial (satellite) communication system 120. The satellite wireless communication system 120 may be employed to perform similar functions to those performed by the conventional terrestrial wireless communication system 20 of FIG. 1. In particular, the celestial wireless communication system 120 typically includes one or more satellites 126 that serve as relays or transponders between one or more earth stations 127 and satellite wireless mobile terminals 122. The satellite 126 communicates with the satellite wireless mobile terminals 122 and earth stations 127 via duplex communication links 130. Each earth station 127 may in turn be connected to a PSTN 132, allowing communications between the wireless mobile terminals 122, and communications between the wireless mobile terminals 122 and conventional terrestrial wireless mobile terminals 22 (FIG. 1) or landline telephones 32 (FIG. 1).

Brief Summary Text (13):
More particularly, the GPS signal 304 generally consists of a spread-spectrum signal that has a code-length of 1023 chips (bits), and it is transmitted at a chip-rate of 1.023 MHz. This results in a code period of one millisecond. Overlaid on top of the spread-spectrum sequence is a 50 bits/second (bps) navigation message which, typically, contains ephemeris/almanac data as well as timing information which is used to timestamp the transmit time of the signal from the GPS satellite 302. The timestamp, which is generally transmitted in each sub-frame of the 1500 bit navigation message, each sub-frame consisting of 300 bits, is used to calculate the integer number of C/A (coarse acquisition Gold code) code lengths between the GPS satellite 302 and current position of GPS receiver 306.

Brief Summary Text (17):
It is known to combine a GPS receiver and radio communication receiver which receives information, such as GPS satellite Doppler information from a terrestrial base station, for use in determining position as described in U.S. Pat. No. 5,663,734 to Krasner entitled "GPS Receiver and Method for Processing GPS Signals". It is also known to provide a GPS receiver with GPS satellite position information transmitted over a communication channel supported by terrestrial cellular telephone or other radio packet data services as described in U.S. Pat. No. 5,365,450 to Schuchman entitled "Hybrid GPS/Data Line Unit for Rapid, Precise, and Robust Position Determination". In addition, various proposals have been submitted to the T1 Standards Committee of the European Telecommunications Standard Institute (ETSI) regarding assisted GPS for GSM radiotelephone communication systems as described in the submittal entitled "Evaluation Worksheet for Assisted GPS" by Ericsson and SnapTrack submitted to the T1P1 working group (of the European Telecommications Standard Institute ETSI) on Jun. 3, 1998. Each of these approaches is generally directed to reducing the time required to determine a position from the GPS data and provide for the transfer of information about the GPS satellites to a combined mobile terminal/GPS receiver from communication networks, such as a terrestrial cellular network. However, these approaches typically require advantaged (clear) communication with the positioning/communication terminal and transfer of specific GPS satellite information to facilitate acquisition and calculation of position.

Brief Summary Text (29):
In a further aspect of the present invention, satellite communication timing information is also obtained from the satellite radiotelephone system communication and the plurality of trial positions is generated based on the obtained timing

information. The timing information may be timing delay information in which case the plurality of trial positions are selected along an arc of positions substantially equidistant from a satellite transmitting the satellite radiotelephone system communication based on the timing delay information. Depending on the accuracy of the timing delay information, the plurality of trial positions may be selected along at least one arc of positions substantially equidistant from a satellite transmitting the satellite radiotelephone system communication based on the timing delay information wherein each of the trial positions is located no more than approximately 150 kilometers of another of the plurality of trial positions.

Detailed Description Text (46):
As described above, a particular chip of the GPS signal from satellite_1 is expected to be received somewhere between 11.3 ms to 12.3 ms prior to receiving it from satellite_2. Thus, the delay observed by the user equals 11 ms plus some fractional offset or 12 ms plus some fractional offset. As the code phase measurements cp1 and cp2 indicate that the fractional difference between the two received signals is 0.4955 ms, two possible values for the delay between satellite_1 and satellite_2 signals are considered, namely 11.4955 ms and 12.4955 ms. Because the actual delay is expected to exist within the interval (11.3 ms, 12.3 ms), it may be assumed that the user receives the GPS signal from satellite_1 11.4955 ms sooner that transmitted by satellite_2. Note that it would be expected to be impossible to interpret this user-observed delay to be 12.4995 ms due to the trial position spacing constraint.

Detailed Description Text (74):
In the ACeS system, forward (downlink) channels from the satellite 126 to the mobile terminal 400 use one 200 KHz bandwidth carrier partitioned into eight time division multiple access (TDMA) slots. The corresponding reverse (uplink) channel uses four sub-carriers spaced at 50 KHz intervals with each sub-carrier partitioned into 2 TDMA slots. The downlink common control channels are mapped onto one 200 KHz bandwidth forward channel and the RACH channel is mapped onto one of the four corresponding 50 KHz uplink sub-carriers. FIG. 8 illustrates the mapping of the common control channels onto the forward and reverse channel carriers. Return sub-channel zero, as shown in FIG. 8 is configured so that RACH access periods have a period of 2-TDMA frames. In large spot-beams, the RACH access periods can be configured to be as long as 9 frame periods to prevent overlap of RACH accesses in adjacent RACH access periods.

Detailed Description Text (75):
The described ACeS protocol may be modified according to an embodiment of the present invention to allow a mobile terminal 400 operating in disadvantaged mode to obtain timing information corresponding to the round-trip delay between the satellite 126 and the mobile terminal 400. According to the present invention, the round-trip timing delay is then used in resolving the one-millisecond ambiguity in computing GPS pseudo-ranges. In order to obtain the timing information in disadvantaged mode, the ACeS air-interface is modified to add a High-Power Random Access Channel (HRACH). GPS satellite ephemeris and timing information may also be provided. The common control channels have four carriers in the reverse direction. Depending on capacity requirements desired to support the GPS functionality, one to three of the reverse sub-carriers are allocated to the HRACH channel. HRACH channels may also provide additional functionality to the ACeS system such as providing a method for the mobile terminal 400 to register in a disadvantaged mode.

Detailed Description Text (86):
Assuming that, for the ACeS system, one satellite 126 can support 2,000,000 users and there are 140 spot-beams 136 per satellite 126, each spot-beam can support approximately 14,285 users. In a worst-case situation, an HRACH access will then take 28 bursts which results in HRACH access period of 28* (60/26)=64.6 msecs. Using the expected peak throughput of 2.7 attempts per successful access, each HRACH access at peak capacity will take 64.6*2.7=174.46 msecs per successful access on the HRACH channel. This results in a peak capacity of 20,635 successful accesses per hour, not including retries due to lost HRACH frames. Dividing the capacity by the number of users in a spot-beam, results in one HRACH channel being able to support 1.44 accesses per hour per user. Additional capacity could be obtained by adding additional HRACH channels on other unused return sub-carriers. Additional coding gain could be realized by reducing the capacity of each HRACH channel and increasing

the number of bursts.

Detailed Description Text (90):
At block 504, satellite 126 calculates a round trip delay for the received HRACH request. At block 506, satellite 126 transmits the computed timing delay along with an identifier on the HPACH channel for receipt by mobile terminal 400. The format for the identifier and transmission using the HRACH and HPACH have been previously described with reference to FIGS. 7-9 above.

CLAIMS:

15. A method according to claim 14 wherein the timing information is timing delay information and wherein the generating step comprises the step of selecting the plurality of trial positions along an arc of positions substantially equidistant from a satellite transmitting the satellite radiotelephone system communication based on the timing delay information.

16. A method for determining a position of a mobile terminal comprising the steps of:

obtaining an identification of a spot-beam in which the mobile terminal is located from a satellite radiotelephone system communication;

obtaining satellite communication timing information from the satellite radiotelephone system communication;

generating a plurality of trial positions within the spot-beam based on the obtained timing information;

determining candidate position fixes for the mobile terminal for at least two of the plurality of trial positions based on GPS signals received by the mobile terminal from a plurality of global positioning system (GPS) satellites;

selecting one of the determined candidate position fixes as the position of the mobile terminal; and

wherein the timing information is timing delay information and wherein the generating step comprises the step of selecting the plurality of trial positions along at least one arc of positions substantially equidistant from a satellite transmitting the satellite radiotelephone system communication based on the timing delay information wherein each of the trial positions is located no more than approximately 150 kilometers of another of the plurality of trial positions.

27. A position computation system for a mobile terminal, comprising:

means for obtaining an identification of a spot-beam in which the mobile terminal is located from a satellite radiotelephone system communication;

means for obtaining satellite communication timing information from the satellite radiotelephone system communication;

means for generating a plurality of trial positions within the spot-beam based on the obtained timing information;

means for determining candidate position fixes for the mobile terminal for at least two of the plurality of trial positions based on global positioning system (GPS) signals received by the mobile terminal from a plurality of GPS satellites;

means for selecting one of the determined candidate position fixes as the position of the mobile terminal; and

wherein the timing information is timing delay information and wherein the means for generating comprises means for selecting the plurality of trial positions along at least one arc of positions substantially equidistant from a satellite transmitting the satellite radiotelephone system communication based on the timing delay

information wherein each of the trial positions is located no more than approximately 150 kilometers of another of the plurality of trial positions.

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L1: Entry 4 of 5 File: USPT Jul 16, 1974

DOCUMENT-IDENTIFIER: US 3824340 A
TITLE: VARIABLE TRANSMISSION TIME DELAY COMPENSATION ARRANGEMENT

Detailed Description Text (4):
Referring to the FIGURE variable delay circuit 1 is included in a ground station 2 which is in communication with a satellite 3 by means of transmitter 4 and receiver 5. The variable transmission time delay compensation arrangement of the present invention includes variable delay circuit 1 coupled to a composite frequency stabilized video signal source 6 through means of directional coupler 7 and combiner 8. The composite signal at the output of source 6 includes the video, sync pulses and color subcarrier. This composite signal passes through variable delay circuit 1 to directional coupler 9 the output signal of which is presented to transmitter 4 through means of a 6 MHZ low pass filter 10. The composite signal is then operated upon by transmitter 4 for transmission to satellite 3 which includes therein a radio repeater which will propagate the output of transmitter 4 to a receiving TV studio (not illustrated) and also back to ground station 2 for reception by receiver 5. The output signal of receiver 5 is filtered by filter 11 so as to pass only the 3.58 MHZ color subcarrier. The output signal of filter 11 is coupled to mixer 12 which receives a local oscillator signal from local oscillator 13 to translate the frequency of the color subcarrier at the output of filter 11 to a value of frequency above the frequency of the composite color TV signal, such as 9.00 MHZ, so that the output signal of mixer 12 may be applied to combiner 8 wherein it is frequency multiplexed with the original composite video signal and propagated through delay circuit 1. To achieve the 9.00 MHZ output signal of mixer 12, local oscillator 13 generates a frequency having a value equal to 12.58 MHZ and mixer 12 includes therein appropriate circuitry to select the difference frequency between the frequency of the output signal of filter 11 and the frequency of the output signal of oscillator 13.

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L3: Entry 28 of 40 File: USPT Mar 6, 1990

DOCUMENT-IDENTIFIER: US 4907247 A
TITLE: Satellite delay simulation system

Detailed Description Text (4):
The present invention proposes a new and useful implementation for testing a digital satellite communication system in which a digital satellite communication terminal on the earth is connectable to another such terminal on the ground by satellite delay. Specifically, in the event of testing this kind of communication system by using a satellite delay simulator which introduces a simulated delay involved in the propagation of an electromagnetic wave from the earth to a satellite transponder and then from the transponder to the earth without using the transponder, the present invention contemplates to provide the delay by using clocks particular to the communication terminals which are different from a clock of the delay simulator. To provide such a delay, transmit data and a communication control signal arranged in a time sequence by a clock of a communication terminal are once rearranged in a time sequence by a clock of the delay circuit to be delayed thereby, then the delayed data and control signal are restored to the original time sequence associated the clock of the communication terminal, and then the resulting data and control signal are transmitted. The two times of conversion of time sequence are implemented by means having exactly the same construction.

Detailed Description Text (5):
Referring to FIG. 3, there is shown a digital satellite communication system 30 including testing equipment which is implemented by a satellite delay simulator embodying the present invention. In the figure, the same or similar structural elements and data, signals and clocks as those shown in FIG. 2 are designated by like reference numerals and characters. As shown, the testing equipment is made up of a single multi-channel satellite delay circuit 32 and clock matching circuits two of which are assigned to each digital satellite communication channel, i.e., interconnectable communication terminals 12(1) and 14(1), 12(2) and 14(2), ..., 12(n) and 14(n). Specifically, n clock matching circuits 34(1) to 34(n) are provided between the delay circuit 32 and the communication terminals 12(1) to 12(n), and n clock matching circuits 34'(1) to 34'(n) are provided between the delay circuit 32 and the communication terminals 14(1) to 14(n). In the illustrative embodiment, the satellite delay simulator is constituted by the delay circuit 32 and clock matching circuits 34(1) to 34(n) and 34'(1) to 34'(n). The delay simulator is capable of handling up to n channels of transmit data alone and without effecting the local clocks assigned to the communication terminals 12(1) to 12(n) and the local clocks assigned to the communication terminal 14(1) to 14(n), by synchronizing transmit data DATA1 to DATAn and RTN DATA1 to RTN DATAn to the clock (system clock) particular to the delay circuit 32.

Detailed Description Text (6):
FIG. 4 shows a specific construction of two of the clock matching circuits 34 which are provided on the same channel. As shown, a first clock matching circuit 340 is disposed on a transmit route extending from any of the transmit terminals 12(1) to 12(n) to the satellite delay circuit 32, while a second clock matching circuit 340' is disposed on a transmit channel extending from the satellite delay circuit 32 to one of the receive terminals 14(1) to 14(n) which is associated with the transmit terminal. The clock matching circuit 340 converts a time sequence derived from the local clock of the transmit terminal 12 into a time sequence which is based on the system clock of the delay circuit. On the other hand, the clock matching circuit 340' converts, or restores, the time sequence outputted by the circuit 340 into the original time sequence derived from the local clock. The clock matching circuit 340 comprises input latches 36 and 38 arranged in two consecutive steps, a FIFO memory

40, a timing generator 42, a burst clock generator 44, and an output latch 46. Likewise, the clock matching circuit 340' comprises input latches 48 and 50, a FIFO memory 52, a timing generator 54, a burst clock generator 56, and an output latch 58.

Detailed Description Text (7):
In FIG. 3, transmit data DATAm from the m-th communication terminal 12(m), for example, is retimed by the input latches 36 and 38 of the first clock matching circuit 340 by using a transmit clock CLKm (FIG. 5A) particular to the communication terminal 12(m). The retimed data is written in the FIFO memory 40 in synchronism with a clock RVCLK which is produced by inverting the transmit clock CLKm. The timing generator 42 senses the beginning of a packet or burst on the basis of the communication control signal CARm (FIG. 5B) and delivers a reset signal RESET (FIG. 5C) to the FIFO memory 40. Another function of the timing generator 42 is to sense a clock BCLK (FIG. 5E) contained in the burst and feeds it to the burst clock generator 44. When the burst clock generator 44 receives the clock BCLK in the burst from the timing generator 42 and a reference transmit clock CLK (FIG. 5F) from the satellite delay circuit 32, it generates the same number of reference transmit clock pulses CLK as the clock pulses BCLK while delivering them to the FIFO memory 40 in the form of a read clock RCLK (FIG. 5G). Consequently, the transmit data and communication control signal read out of the memory 40 timed to the read clock RCLK are arranged in a time sequence which is based on the reference transmit clock CLK. More specifically, the data and control signal read out of the memory 40 are retimed by the output latch 44 by using the reference transmit clock CLK, then fed to the delay circuit 32 in the form of transmit data DATAm and communication control signal CARm, and then outputted by the delay circuit 32 with a predetermined time of delay.

Detailed Description Text (8):
The delayed data RTN DAAm and communication control signal RTN CARm are returned from the delay circuit 32 to the second clock matching circuit 340'. In response, the clock matching circuit 340' retransforms the data and control signal arranged by the reference transmit clock CLK into a time sequence which is associated with the transmit clock of the communication unit 14(m). More specifically, the delayed data RTN DATAm and communication control signal RTN CARm are retimed in two consecutive steps by the input latches 48 and 50 and written in the FIFO memory 52. The timing generator 54 produces a timing from the delayed communication control signal RTN CARm to feed a reset timing to the FIFO 52. Also, when the timing generator 54 senses the clock in the burst, it delivers it to the burst clock generator 56. Receiving the transmit clock CLKm of the communication terminal 12(m) as well as the clock from the timing generator 54, the burst clock generator 56 generates the same number of transmit clock pulses CLKm as the clock pulses contained in the burst while applying them to the FIFO memory 52 in the form of a read clock. As a result, the data and communication control signal read out of the memory 52 are arranged in a time sequence associated with the transmit clock of the communication terminal 12(m). That is, the data and control signal outputted by the memory 52 are retimed by the output latch 58 by using the transmit clock CLKm of the communication terminal 12(m) and then transmitted to the receive terminal 14(m) as if they were delayed by satellite delay, i.e. as a delayed signal.

CLAIMS:

4. A satellite delay simulator as claimed in claim 1, wherein each of said clock matching circuits which constitute said first clock matching means comprises:

a first input latch for retiming transmit data and a communication control signal from any of said communication terminals on the transmit side which is provided on any of the channels by a clock which is fed from said communication terminal;

a first FIFO (First-In First-Out) memory for writing the retimed transmit data and communication control signal in response to the clock;

a first timing generator for feeding a reset signal to said first FIFO memory upon sensing a beginning of a burst out of the communication control signal and sensing and outputting a clock contained in the burst;

a first burst clock generator for generating, in response to the clock in the burst and the clock from said delay simulation means, the same number of clock pulses as pulses of the clock of the burst while delivering the clock pulses to said FIFO memory in the form of a read clock; and

a first output latch for retiming the transmit data and communication control signal read out of said FIFO memory in synchronism with the clock from said delay simulation means and feeding the retimed communication data and communication control signal to said delay simulation means.

5. A satellite delay simulator as claimed in claim 4, wherein each of said second clock matching circuits which constitute said second clock matching means comprises:

a second latch for retiming the delayed transmit data and communication control signal from said delay simulation means in response to the clock which is fed from said delay simulation means;

a second FIFO memory for writing the retimed transmit data and communication control signal in response to the clock from said delay simulation means;

a second timing generator for deliverig a reset signal to said second FIFO memory upon sensing a beginning of a burst out of the communication control signal and sensing and outputting a clock contained in the burst;

a second burst clock generator for generating, in response to the clock of the burst and the clock from said communication terminal, the same number of clock pulses as pulses of the clock of the burst while delivering the clock pulses to said second FIFO memory in the form of a read clock; and

a second output latch for retiming, in response to the clock from said communication terminal, the transmit data and communication control signal which are read out of said second FIFO memory and sending the retimed transmit data and communication control signal to one of said communication terminals on the receive side.

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L3: Entry 32 of 40 File: USPT Feb 3, 1987

DOCUMENT-IDENTIFIER: US 4641304 A
TITLE: Announced retransmission random access system

Detailed Description Text (6):
Assume the simplest situation where no conflict can occur. Assume that station A wants to send a message to station B. Station A generates a packet of data and by random selection of message slot in the very next frame transmits it via message slot 94, in frame 98 to station B. Message slot 94 contains 8 minislots as defined above. When Station A generates this packet of information, one of the minislots in message slot 94 is picked at random and a pulse placed therein. Let's assume that this minislot is minislot 2 in FIG. 2. If Station A and Station B are the only two stations involved and no other stations are sending messages, there are no complications. The message is transmitted via the satellite, Station B receives it, and there is a portion of the data packet which contains an address which identifies Station B as the recipient of the message. Station B recognizes the message as being its own and receives and stores it. However, it should be noted that all stations in addition to Station B and A receive the information that a message has been transmitted in message slot 94 and that minislot 2 has been selected. The selection of message slot 94 means that if another station had in fact transmitted a message such as Station C during the same message slot 94, the information contained in the message slot would be garbled and unintelligible to both recipients.

Detailed Description Text (9):
Let's assume Station A wants to send a message to Station B. It gets this packet of information and by random selection sends it in message slot 94. This message slot 94 contains a number of minislots which have been labeled 1, 2, 3 . . . K in FIG. 2. When Station A generates its data packet it's going to put a pulse at random in one of the minislots. Assume it picks minislot 2 and places a pulse in minislot 2. If Station A and Station B are the only two stations involved, and no other station is sending messages, there are no complications. The message is transmitted via the satellite, Station B receives it, and there is a part of the packet of information that contains an address to Station B which says, in effect, Station B this is your message. Station B recognizes the message as being its own and receives and processes such message. However, it's very possible that one of the other stations, for example Station C, transmits a message to Station D about the same time Station A transmitted its message. Station C formed its package and transmitted it during message slot 94. Now there are two messages in one message slot 94 and they are conflicting. One of them is addressed to go to Station B and the other is addressed to go to Station D. Assume that Station C arbitrarily picked at random minislot 3 as its retransmission choice in case of a conflict. The selection of minislot 3 has the following meaning. There are two stations, A and C, transmitting in the same message slot 94. Station A, by its selection of 2, had declared that it will retransmit its packet in the event of a conflict in the later message slot 2 during a subsequent frame, which frame is measured by the round trip propagation time of the entire system from one ground station to the common satellite and back to another ground station. Station C by its selection of minislot 3 has declared that if there is a conflict it will retransmit its message in message slot 3 on the next frame after the round trip propagation time of the whole system which would be the same frame as the retransmission of the message originally transmitted by Station A.

Detailed Description Text (15):
Logic is provided in the ground station that will select a new minislot for each of transmitters A and C. Assume that transmitter A picks minislot 1 (in the CMP) and transmitter C picks minislot 5 (in the CMP) after the second propagation trip to the satellite. In the next frame, after the next propagation time to the satellite,

transmitters A and C will transmit their message in message slots 1 and 5 provided there is no conflict with other retransmitted messages. If there are conflicts with other retransmitted messages, the system must go through this process again.

Detailed Description Text (25):
The transponder in the satellite reflects the received data back where it is picked up by an antenna corresponding to antenna 222 of each of the ground stations, then through amplifiers corresponding to amplifier 220 of FIG. 6, to the RF subsystem which is now a down converter, then in parallel to bus 216 into full duplex modem 214. The received data is then supplied in parallel form via bus 226 to the cyclic redundancy check (CRC) decoder 228, which determines if there is an error. If an error exists it will almost always be due to more than one message being received at a given time. How such an error is detected is a separate subject and is explained in detail in the following publications.

Detailed Description Text (30):
Assume now that a conflict or collision does occur. More specifically assume that two channels or two transmitters A and B both transmit at the same time on the same message slot. It is to be understood that the conflict occurs upon the reception of the data packet from two different transmitters since the transmit scheduler 210 is unique only to the data packet generated in the single transmitter shown in FIG. 6. Thus the output of transmit scheduler 210 initially is supplied to full duplex modem, which is also unique to only one transmitter at this point. The output of modem 214 goes to converter 218 and antenna 222 as a clean signal. If transmitter C had transmitted at that same time, the satellite would be retransmitting back at the same time, and transmitter A of FIG. 6 would receive two messages, one originating from transmitter A and the other from transmitter C. Both data packets are being received by antenna 222 at the same time and being supplied to down converter 218 and into full duplex modem 214 simultaneously. One of these signals will be a signal via dotted lead 224 from full duplex modem 214 to transmit scheduler 210 and labeled "received minislot announcement" which is a valid announcement to be acted upon only if the message error indicator 252 is positive (error condition). The system always receives that signal back because it always has at least one minislot filled indicating the proper message transmitted. However, the system will also receive an output from CRC 228 indicating an error via lead 252, which is supplied via lead 258 back to transmit scheduler 210, which indicates there is an error and that error is probably the fact that two transmitters were transmitting at the same time. The transmit scheduler 210 will then examine the output of lead 252 and conclude that an error exists and that certain results must occur. These results are those shown essentially to the right of transmitter scheduler 210 in FIG. 6 and set forth above in the specification.

Detailed Description Text (34):
It should be noted that the logic 300 contains the unavailable message slots in the next frame. At the end of the current frame, before the occurrence of the next available frame, the identification of the unavailable message slots are dumped into a RAM table contained in block 302. The framing sync signals, the message sync signals, and the minislot sync signals appear on leads 242, 244 and 246 in FIG. 6 and are all generated by timing sync module 240 which is common to all of the transmitters. The timing sync module 240 in turn derives its timing signal from the output of the full duplex modem 214 of FIG. 6 in a well known manner. When each new packet of information arrives in a single packet transmit buffer 206 of FIG. 7 from FIFO 202 of FIG. 6 the transmission of that new packet is initiated. While the process is in fact started when the new packet arrives in the single packet transmit buffer 206 of FIG. 7, it does not actively enter into the process of selecting a message slot until the start of the next frame. Such delay exists until the beginning of the next frame when one of the available message slots is selected by using the information of table 302. As block 302 contains the table of unavailable slots, the logic in block 310 must in fact select one of the remaining message slots to obtain an available and usable message slot. A random selection is effected by means of a random number generating logic contained in the logic of block 310. Assume that the message slot randomly selected is message slot 7. Appropriate timing and delay means is provided within block 312 to delay the placing of the data package into the frame until message slot 7 occurs, at which time the data package is inserted into message slot 7 in block 312.

Detailed Description Text (37):
Upon retransmission from the satellite, the transmitter of FIG. 6, now functioning as a receiver, receives the signal that's transmitted and supplies it to amplifier 220, down converter 218, full duplex modem 214, CRC logic 228 of FIG. 6, and if the message is correct, through logic 232 to a data receiver 235. The logic blocks 320, 322 and 324 correspond generally to the logic 228, 232 and 235 of FIG. 6. More specifically, if decision block 324 of FIG. 7 after observing the signal on lead 252 finds no error then it energizes the clear buffer signal logic 326 to clear the single packet transmit buffer logic 206 which then applies a new data packet into the system via delay means 308. If there is an error, that is a collision resulting from the simultaneous transmission of two data packets, then the output of decision block 324 so indicates by sending a signal to logic 330 which is labeled "take packet from input buffer." The input buffer so indicated is the FIFO 202 shown in FIG. 6 and in fact means the retransmission of the same data packet whose transmission has failed.

Detailed Description Text (48):
1. All transmissions are accompanied by a retransmission slot (randomly selected from 1 to K) announcement in the minislotted subchannel.

Detailed Description Text (63):
In block 406 the data packet goes to block 408 where one of the K minislots is randomly selected and then appended to the data packet in block 410. The appending of the minislots of the data packet means that the minislot is positioned in a small dedicated section of the RAM in block 410 of FIG. 8. Subsequently, in block 412, the data message is transferred to the modem 214 of FIG. 6 for transmission via antenna 222 to the satellite and then to the other stations. The announced minislot number 404 in passing through blocks 406, 408, 410 and 412 is supplied to storage logic 414 where the announced minislot number is stored. When the transmitted data packets arrive back from the satellite the transmitter of FIG. 8 compares it with the transmitted message received to determine whether an error occurred. The decision as to whether conflict occurred is made in decision block 418 by examining lead 450. If there is no error then the signal is sent to buffer signal logic 420 which asks the single packet transmit buffer 454 for a new data packet for the next transmission and the process starts anew. If there is an error detected in block 18, then the retransmission cycle is started. First, the block 424 verifies whether the announced retransmission was free of conflict. This is done by comparing the announced retransmission minislot (stored in 414) with the list of repeated entries in block 446. If no conflict exists, the retransmission is allowed to proceed as announced via blocks 442, 426, 408, 410 and 412, as in previously described cases. If there is a second order conflict (detected in block 424), then the announced retransmission is aborted by setting null data in block 480 and then transmitting only a minislot announcement in the CMP via blocks 438, 408, 410 and 412.